

Title: High Pressure Multi Anvil Split Sphere Apparatus & Supporting Accessories

Description of the Project: Procure a High Pressure Multi Anvil Split Sphere Apparatus that has the capability to process large samples (up to 1cm^3) at pressures of 8 GPa (1.1M psi) and temperatures of 2500°C . The processing environment of the apparatus will allow 1) sintering of nanocrystalline ceramics (spinel etc.) at high pressures and lower temperatures for transparent armor and laser applications (collaboration with Optical Sciences), 2) sintering of nano-architected thermoelectrics, magnetocaloric, and superconducting materials (collaboration with Multifunctional Materials), 3) annealing studies of unstable high temperatures phases (GaN, diamond, SiC) and activation of ion implantation doped layers in SiC, GaN substrates, and 4) exploration of novel phases (e.g. superhard materials) by verifying computational predictions (collaboration with Computational Materials Science). Along with the high pressure and high temperature capabilities, the proposed apparatus will be equipped with vacuum and inert environment capabilities, multiple high current feedthroughs, and *in situ* characterization (electrically based signals). The high pressure apparatus will also be updated with spring anvils allowing much faster and easier operation and multiple sets of second stage anvils to allow various sample size/ pressure range combinations – further expanding the versatility of the apparatus. The apparatus will have higher pressure range, larger sample volume, additional options to create and control environment conditions for the sample treatment and easier, less time consuming preparation of the apparatus for each experiment – all of which will significantly expand NRL's capabilities in high pressure research.

Detailed High Pressure Multi Anvil Split Sphere Apparatus Specifications

No	Item description	Qty
	Furnace for high pressure treatment 303	
1	Main body parts:	1
1.1	Upper semibody	1
1.2	Lower semibody	1
1.3	Semicylinder lock	2
2	Furnace bed:	1

2.1	Base frame	1
2.2	Rear mount unit + mounting parts	1
2.3	Screw leg (foot) 6 + guide rails (4) + carriage (6) + fasteners for lower semibody + stop (2) + fasteners	1
2.4	Tray (2) + décor	1
3	Lifting unit of upper semibody:	1
3.1	Actuator with accessories	1
3.2	Set of brackets (2) + axes (2) + fasteners	1
3.3	Hinge kit for semibodies	2
4	The electric power system	1
4.1	Current power supply	1
4.2	Toroidal magnetic circuit with the primary winding (with multiple outlets) and mounting parts	1
4.3	Secondary power winding with cable lugs	1
4.4	Bus of the upper power current lead	1
4.5	Current transformer of primary winding	1
4.6	Current transformer of secondary winding	1
4.7	Signal pin assembled	8
4.8	Plug assembly for auxiliary power current feedthrough	4
5	HP Hydraulic system:	1
5.1	HP pump station	1
5.2	Electric motor drive for HP valve + customized valve cylinder + pneumatic valves	1
5.3	Mounting parts for HP pump system	1
5.4	High pressure (HP) coiled tube with seals	1
5.5	High pressure drainage fittings	1
6	Control system (allows remote access):	1
6.1	Control system enclosure	2
6.2	Touch screen monitor of the control system	1
6.3	Sensors (4) and transducers (?)	1
7	Control software for the HP furnace 303	1
8	Automatic water cooling system, enclosed in a frame and mount unit	1
9	Automatic pneumatic system, enclosed in a frame and mount unit	1
10	Pressmold unit:	

10.1	Set of the first stage spherical anvils 300_110 (8)	1
10.2	Set of the first stage spherical anvils 300_106 (8)	1
10.3	Equipping the set of the spherical anvils (galvanizing, painting, plates (24), a springs with a seal (30) and textolite stops, textolite stripes and squares)	2
10.4	Side cross with stopper	4
10.5	Cross for current lead with hole	2
10.6	Side plate	4
11	Second stage anvils:	
11.1	Second stage anvils 55.8-57.5P18.1-22.9	8
11.2	Second stage anvils 54.1K18.1	10
12	Upper membrane assembled:	1
12.1	Upper membrane with holes	1
12.2	Upper unified power water-cooled current lead (increased channel) completed with rubber seal, plate insulator of current lead and current lead nut	1
12.3	Sliding ring of the current lead	1
12.4	Upper plate with stop-pin and spring attached to the membrane	4
12.5	Signal current lead attached to the membrane	3
12.6	Signal cable connected to the signal current lead	3
13	Lower membrane assembled:	1
13.1	Lower membrane with holes	1
13.2	Lower unified power water-cooled current lead (increased channel) completed with rubber seal, textolite plate and washer insulator of current lead and current lead nut	1
13.3	Sliding ring of the current lead	1
13.4	Lower plate with stop-pin and spring attached to the membrane	4
13.5	Signal current lead attached to the membrane	3
13.6	Signal cable connected to the signal current lead	3
13.7	Stopper attached to membrane	4
13.8	Set of the textolite washers for the lower power current lead	1
14	Set of lock ring 350 and spring ring 350:	2

14.1	Lock ring 350	2
14.2	Spring ring 350	2
15	Spare parts for membrane	
15.1	Upper membrane with holes	1
15.2	Upper plate with stopper and spring	4
15.3	Lower membrane with holes	1
15.4	Lower plate with stopper	4
15.5	Set of spare gaskets (textolite and rubber) for signal pins (part #)	1
16	Tools and accessories:	
16.1	Dummy 110	1
16.2	Positioning centering ring 350	1
16.3	Accessories for installing and removing the locking ring	1
16.4	Wrench for the HP coiled tube	1
16.5	Wrench for the nut of the unified power water-cooled current lead	1
16.6	Tool for installation of the current-carrying contact into membrane	1
16.7	Handle for assembling the first stage of spherical anvils	1
16.8	Guiding tool (to assemble spherical anvils in the lower membrane)	1
16.9	Left support for assembling spherical anvils	2
16.10	Right support for assembling spherical anvils	2
16.11	Tray for the second stage anvils	1
17	Consumables, materials for the furnace preparation for the run cycle:	
17.1	Insulator 110 (laminated paper - Tufquin paper)	6
17.2	Insulator 110 with hole (laminated paper - Tufquin paper)	2
17.3	Insulator 110 for side cross (laminated paper - Tufquin paper)	4
17.4	Textolite insulator for cross	2
17.5	Set of the insulating textolite plates (plates 28x173x1 mm - 24, plates 32x32x1 mm - 8, for cylinder springs d=20, h=1 mm - 36)	1
17.6	Ceramic crucible P23.6_28.4 with graphite heater assembly	100

Max AC Input Power	2.5 kW
Input AC Voltage	208-240 V
Frequency	50-60 Hz
Phases	1 phase
Max AC Voltage on a Heater	4 V
Max AC Current on a Heater	600 A
Max AC Output Power	2.0 kW
Max Temperature inside HP container	2500°C
Temperature control, accuracy	+/- 2 °C
Max Apparatus Oil Pressure	2500 bar
Oil pressure control, accuracy	+/- 2 bar
Recommended oil	Shell Vitrea 32,Exxon Nuray 32,BP Energol CS 32
Max Pressure in a 8 cm ³ HP container	6.0 GPa
Max Pressure in a 1 cm ³ HP container	10.0 GPa
Cooling water requirements	Distilled water is recommended
Water flow	0.2 – 0.4 m ³ /h
Water pressure	2 bar
Dimensions:	
HP Furnace installed	
Width	950 mm
Length	2230 mm
Height	1570 mm
Weight	3500 kg
Semibody	
Diameter	640 mm
Height	280 mm
Weight	502 kg
Semicylinder lock	
Length	950 mm
Width	475 mm
Height	500 mm
Weight	800 kg
Furnace bed	
Length	1820 mm
Width	675 mm
Height	1200 mm
Weight	250 kg